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The Market's Reaction to Discount Changes What's Behind the Announcement Effect?

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THE MARKET'S REACTION TO DISCOUNT CHANGES: WHAT'S BEHIND THE ANNOUNCEMENT EFFECT

ABSTRACT

Market interest rates respond to discount rate changes. What is the reason for this response. This paper investigates several competing hypotheses of why markets respond to discount rate changes. Evidence that the response is invariant to changes in the Federal Reserve's operating procedure suggests that it is purely an "announcement effect." Contrary to common belief the evidence suggests that the does not depend critically on whether the discount rate change is unanticipated, because all discount rate changes appear to be largely unanticipated. Additional evidence suggests that, despite the fact that there have been instances when discount rate was used to signal a change in policy, e.g., the one percentage point increase in the discount rate in October 1979, generally speaking, discount rate changes do not appear to have "signaled" a change in monetary policy. This suggests that the common assertion that market interpret discount rate changes as a signal of a change in Fed policy is incorrect. It appears that changes expectations about monetary policy is not the only reason--and perhaps not the most important reason--for the market's reaction to changes in the discount rate.

KEYWORDS: Discount rate, federal reserve operating procedure, heteroskedasticity, unanticipated market efficiency, monetary policy

JEL CLASSIFICATION: E4, E43, E44, E60

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It is commonly believed that discount rate changes alter the public's expectations about the future course of monetary policy, interest rates, prices and economic activity. At one time it was believed that a discount rate announcement was an effective way to inform the public of the Fed's intentions and that such signaling had a stabilizing effect on markets because it reinforced monetary policy objectives. Analysis by Friedman (1959) and Smith (1956, 1958), however, turned professional sentiment, if not the public's perception, away from this view.

Waud (1970) argued that establishing the statistical significance of an announcement effect on interest rates, stock prices, etc. is "logically prior" to determining the real impact of announcements on the economy. Subsequent research has created a considerable volume of empirical evidence suggesting that interest rates, stock prices and the foreign exchange value of the dollar frequently do respond in a statistically significant way to discount rate changes that are made for reasons other than technical--i.e., other than to bring the discount rate in line with market interest rates.[1] What remains unclear, however, is why markets respond to such announcements.

It is often asserted that interest rates respond to discount rate changes because bank borrowing and, therefore, the supply of reserves is positively related to federal funds-discount rate spread. Indeed, Roley and Troll (1984) and Smirlock and Yawitz (1985) argue that because of

the "direct effect" of discount rate changes on market interest rates, interest rates should respond significantly to discount rate changes only when the Fed is targeting non-borrowed reserves--the response should be insignificant when the Fed is targeting the federal funds rate.[2]

Thornton (1986), however, argues that the fact that interest rates respond only to non-technical discount rate changes is inconsistent with the "direct effect" hypothesis because if this were the case, market interest rates would respond to all discount rate changes and not just to non-technical changes. Thornton (1982, 1986) argues that the market does not respond to technical discount rate changes because they do not provide markets with new information about either the course of monetary policy or the economy: interest rates do not respond to discount rate changes *per se*, but to the new information which the announcements provides.[3] However, it is impossible to separate Thornton's "announcement effect" hypothesis from the "direct effect" hypothesis if technical discount rate changes are anticipated, while non-technical changes are not. Indeed, Smirlock and Yawitz (1985) attribute the difference in the market's response to technical and non-technical discount rate changes as evidence of market efficiency, arguing that the market responds only to non-technical discount rate changes because technical changes are anticipated while non-technical changes are not.[4]

While many analysts have attributed the market's response to discount rate changes as an "announcement effect," historically there have been two different, though not necessarily mutually exclusive,

interpretations of the announcement effect. The first views non-technical discount rate changes as a signal of a change in monetary policy, with increases signaling a movement toward restraint and decreases a movement toward ease.[5] The second views discount rate changes as the administrative action of a monetary authority who is in a unique position to judge the course of interest rates or economic activity, whether it is responsible for the course or not.[6]

Despite the wide variety of interpretations, relatively little empirical work has been done to differentiate among these competing hypotheses. This article attempts to fill this void. After reviewing the important aspects of the various hypotheses and providing new and very strong evidence that interest rates respond only to non-technical discount rate changes, several hypotheses about why market interest rates respond to non-technical changes in the discount rate are systematically investigated.

Daily observations on the federal funds rate, the Three-month T-bill rate, and the over-night RP rate are used to estimate the response of interest rates to changes in the discount rate. The evidence favors the "announcement effect" hypothesis over the "direct effect" hypothesis by showing that technical changes are no more anticipated than non-technical changes, and by showing--contrary to the evidence presented by Roley and Troll (1984) and Smirlock and Yawitz (1985)--that the effect of a non-technical change in the discount rate is invariant to the Fed's operating procedure. While the evidence about the reason for the announcement effect is less definitive, it suggests

that non-technical discount rate changes generally do not signal changes in Federal Reserve policy.

1. THE EFFECT OF DISCOUNT RATE CHANGES AND THE FED'S OPERATING PROCEDURE

Roley and Troll (1984) and Smirlock and Yawitz (1985) argue that because a discount rate change has a direct effect on bank borrowing and, hence, on interest rates, its effect should vary with the Federal Reserve's operating procedure. In particular, they suggest that the market should not respond to a discount rate change when the Fed is targeting the federal funds rate because the Fed would alter the supply of non-borrowed reserves to offset the effect of the discount rate change on market interest rates. This argument is illustrated in Figure 1. Panel A shows the possible combinations of the federal funds rate, FFR, and non-borrowed reserves, NBR, that are consistent with an equilibrium in the reserve market and panel B shows the demand for borrowed reserves, BORR, conditional on the discount rate.[7] An increase in the discount rate reduces the supply of borrowed reserves relative to total reserve demand. This shifts the demand for borrowed reserves to the left and the equilibrium curve to the right--the decline in borrowed reserves implies the equilibrium funds rate must rise for a given level of NBR. If the Fed were targeting the funds rate, however, the market would anticipate that the Fed would increase the supply of non-borrowed reserves to offset the effect of the decline in borrowed reserves on the federal funds rate.

Alternatively, under a non-borrowed reserves operating procedure, it is presumed that the Fed would maintain non-borrowed reserves at the

target level. Under this operating procedure, the funds rate would rise with the discount rate because of the reduction in borrowed reserves induced by the narrowing of the spread between the two rates.[8] Hence, they conclude that there should be no statistically significant response of market interest rates to a discount rate change when the Fed targeted the federal funds rate and a significant response when the Fed targeted non-borrowed reserves, as from October 1979 to October 1982.

There are several reasons to doubt this analysis and the conclusion. First, the conclusion appears to be predicted on an extremely narrow view of federal funds rate targeting, where the Fed continuously holds the funds rate at the target level. This characterization is at odds with the data. While it is true that daily fluctuations in the federal funds rate were larger during the non-borrowed reserves targeting period, daily movements in the funds rate have been substantial, as we shall see, even when the Fed was targeting it. After all, it is not the absolute movement in the funds rate that is important for determining whether there is a "significant" announcement effect, but its movement on days when discount rate changes were announced relative to its "usual" daily variation.

Second, analogous reasoning suggests there should be no announcement effect after the Fed's switch to a borrowed reserves operating procedure in October 1982, because the evidence suggests that the Fed was essentially targeting the funds rate and not borrowed reserves during much, if not all, of the post-1982 period.[9]

Third, even if the Fed's operating procedure restrains the funds rate, other short-term interest rates are not necessarily restrained by

the Fed's actions. Consequently, movements in these rates can be used to gauge the market's reaction to discount rate changes.

Fourth, this assertion ignores the fact that about half of the discount rate changes that have been made during the past two decades occurred prior to the Fed's dramatic October-1979 change in operating procedure. If the Fed were strictly targeting and controlling the federal funds rate in the way suggested by these authors, there would be no need for such changes. Alternatively, the Fed may use the discount rate to signal its intentions to change the federal funds rate as Cook and Hahn (1988) suggest or, more simply, merely signals its intention to allow the funds rate to move with the market (discount rate changes tend to be preceded by changes in market interest rates).[10] Either way, changes in the discount rate might be associated with statistically significant changes in the funds rate even under interest rate targeting.

Finally, previous research indicates that the response of market interest rates to changes in the discount rate are solely or primarily the result of an announcement effect. If the direct effect were empirically relevant, it should emerge for both technical and non-technical changes. But, the fact that research [Thornton (1982, 1986), Smirlock and Yawitz (1985), Cook and Hahn (1988) and Batten and Thornton (1984, 1985)] has established firmly that domestic interest rates, the foreign exchange value of the dollar and stock prices respond only to non-technical discount rate changes suggests it is the announcement effect and not its direct effect on the supply of borrowed reserves that moves the markets.[11]

1.1 Unanticipated Changes in the Discount Rate

To the extent that technical changes are anticipated, however, the direct effect of technical changes will precede the announcement. Interpreting technical changes as "anticipated" and non-technical changes as "unanticipated", Smirlock and Yawitz (1985) view the lack of a statistically significant market response to technical changes as evidence of market efficiency. It is certainly true that if markets are efficient, discount rate changes can have a statistically significant effect on market interest rates only if they are not anticipated fully. Nevertheless, the lack of a market reaction does not necessarily imply that discount rate changes are anticipated fully. While the market might anticipate technical changes with certainty, it might not know the exact timing of the change. Consequently, if the timing uncertainty is the same for both technical and non-technical changes, their effect on market interest rates would likely be the same, especially if the reaction is due solely to changes in bank borrowing. However, if the announcement of non-technical discount rate changes provides the market with new information about monetary policy or the economy, the differential response might be due to this and not because the former are anticipated while the latter are not.[12] Because the interpretation is important, we test whether technical changes are anticipated while non-technical ones are not. Failure to find that technical changes are anticipated suggests that the market's response to non-technical changes is due to an announcement effect.[13]

2.0 THE FRAMEWORK OF ANALYSIS AND THE DATA

Tests of the effect of discount rate changes are based on an efficient-markets view of interest rates. For simplicity, assume that the best predictor of tomorrow's interest rate is today's rate. With this assumption, market efficiency implies that

(1) $i_t = E_{t-1}(i_t) + \epsilon_t = i_{t-1} + \epsilon_t$,

where ϵ_t denotes the response of the market to new information that it receives in the t^{th} period.

In studies of the market's response to discount rate changes, one element of ϵ_t, a change in the discount rate, is explicitly identified. That is, Equation 1 is rewritten as,

(2) $i_t = i_{t-1} + b\Delta DR_t + \eta_t$.

ΔDR denotes the change in the discount rate in the t^{th} period, b is a parameter representing the average response of interest rates to unanticipated changes in the discount rate and η_t denotes all other news that affects market interest rates. It is assumed that $\eta_t \sim N(0, \sigma^2_\eta)$ and $E(\Delta DR_t \eta_t) = 0$. The market's response to discount rate changes is usually tested by a simple t-test of the coefficient b in an equation like Equation 2.

2.1. The Data

To investigate the effect of discount rate changes, daily data on two overnight rates, the federal funds rate (FFR) and the repurchase rate (RPR), and the 3-month T-bill rate (TBR) for the period from January 3, 1972 to August 23, 1989 are used. FFR is the weighted average of rates on daily transactions for a group of federal funds brokers and RPR is a weighted average of rates between 8:00 and 10:00

a.m. E.S.T. Both rates are compiled by the Federal Reserve Bank of New York. TBR is the rate at "market close," around 4:00 p.m., E.S.T. Discount rate changes are timed by when the announcement of the discount rate change was first made public. Changes in market interest rates are aligned with changes in the discount rate so that the change in the relevant interest rate can reflect the announcement of the discount rate change. Discount rate changes are classified as technical, $\Delta DR(1)$, partially technical and partially non-technical, $\Delta DR(2)$, or purely non-technical, $\Delta DR(3)$, depending on whether the Fed's announcement stated that the change was made solely to keep the discount rate in line with market interest rates, gave this as one of the reasons for the action, or simply made a statement about policy and the state of the economy. The dates of discount rate changes (by the effective date), size of discount rate changes by type and the corresponding changes in the three interest rates are reported in Table 1.

2.2 Heteroskedasticity

The heteroskedastic nature of these data is illustrated in Table 2, which reports the variance for changes in each rate for reserve-settlement Wednesdays and Thursdays, WTH, and all other days, MTF, for the entire period and for the sub-periods where there was a marked change in the variance. While all three rates are characterized by heteroskedasticity, it is particularly true of the federal funds rate whose variance changes markedly over time and by day of the week. An F-test at the equality of the variance are Wednesdays and Thursdays and all other days against the alternative that the variance is larger on the former days, is presented on the third column. The test indicates

that, generally, the variance of ΔFFR is significantly larger on settlement Wednesdays and Thursdays for the entire period and in each of the three sub-periods. The variance of ΔRPR is also significantly larger on settlement Wednesdays and Thursdays than on other days in two of the three sub-periods. In all but the last period, however, the increase in variance is small relative to that of the funds rate. In contrast to both of these rates, the variance of ΔTBR is consistently smaller on settlement Wednesdays and Thursdays, although not significantly so.

3. EMPIRICAL RESULTS

For evidence of an announcement effect to be persuasive, changes in the discount rate should be associated with "large" movements in market rates nearly every time the discount rate is changed. Moreover, the "large" movements should be pervasive across short-term interest rates. From Equation 2 we can see that the variance of the change in the interest rate equals $b^2 var(DR_t) + \sigma^2_\eta$ on days when there are unanticipated discount rate changes and σ^2_η on other days. Hence, the impact of a specific discount rate change on the market can be assessed by determining whether the change in market interest rates on that day are larger than on days when there were no changes in the discount rate.

This can be done efficiently by simply estimating the equation

$$(3) \quad \Delta i_t = X_t \beta' + \epsilon_t, \quad t = 1, 2, \ldots, T,$$

where T is the number of observations on Δi_t and X_t is an N dimensional row vector of observations on discount rate changes in the t^{th} period. That is, $X_t=(0, 0, 0, \Delta DR_t, 0, \ldots, 0)$ if there was a discount rate change in the period. If there was no discount rate change, $X_t=(0, 0,$

0, ..., 0). N is the number of discount rate changes in the T periods and β is an N dimensional row vector of parameters, $\beta=(\beta_1, \beta_2, \ldots, \beta_N)$. While the estimated parameters in Equation 3 are of no interest, *per se*, their t-statistics indicate the number of standard errors by which the market interest rate changed on the day of an announced change in the discount rate relative to all other days.[14] Hence, the t-statistics indicate whether specific discount rate changes were associated with "large" changes in market interest rates. Moreover, this specification is very general -- all tests of the effect of discount rate changes, e.g., Equation 2, are restricted versions of Equation 3.

The t-statistics from estimating Equation 3 are presented in Table 3. All of the estimated equations are adjusted for heteroskedasticity by allowing the variance to differ in each of the three sub-periods given in Table 2 for all three interest rates and by the first and last day of the year and on settlement Wednesdays and Thursdays and during each of the three sub-periods for FFR and RPR.[15] Dummy variables for settlement Wednesdays (DW) and Thursdays (DTH) are included in all of the estimated equations along with a distributed lag of order 10 of the dependent variable; however, the estimated coefficients on the dummy and distributed lag variables are not reported because they are of no particular interest.[16]

Few type 1 discount rate changes have t-statistics larger than two in absolute value, and only one, DR(1)20, has a t-statistic greater than two for all three interest rates. It is interesting to note that this change was announced only two days after the Fed announced its decision to de-emphasize M1 as a monetary policy target. Hence the market may

have perceived it as more than a mere technical change. Thornton (1986) shows that this observation alone accounts for the statistically significant effect of type 1 discount rate changes on the 3-month T-bill rate over the period from October 1982 through June 1986.

Also, there was one instance where the t-statistic was greater than two for both FFR and RPR, DR(1)5. This discount rate change was announced on Tuesday, February 4, 1975 and was effective on settlement Wednesday, February 5. On Wednesday the RP and federal funds rates dropped 94 and 174 basis points, respectively, only to recover 63 and 137 basis points, respectively, on the following Thursday. In contrast, TBR declined 15 basis points on Wednesday and recovered all 15 basis points on Thursday. Another type 1 discount rate change that produced a t-statistic greater than two for the federal funds rate, DR(1)14, occurred on Wednesday, May 28, 1980 and was effective on Thursday, May 29. On Wednesday the federal funds rate increased by 265 basis points and fell 174 basis points on Thursday: RRP and TBR reported modest increases on both Wednesday and Thursday. Thus, it appears that the larger drop in the funds rate on Thursday was a normal readjustment to Wednesday's increase and not due to the minus one percentage point technical realignment of the discount rate. The only other type 1 discount rate change that had a t-statistic greater than two on the federal funds rate had a negative sign. Indeed, it is interesting to note that nearly half of the discount rate changes made for technical reasons are associated with movements in market rates in the opposite direction. These results support earlier findings [Thornton (1982, 1986), Batten and Thornton (1984, 1985), Smirlock and Yawitz (1985),

Cook and Hahn (1988)] that the market does not respond to discount rate changes made for solely technical reasons.

An analysis of the effects of individual type 2 and 3 discount rate changes shows that there were only <u>two</u> instances when all three rates moved by more than two standard errors in response to the same discount rate change. Both were type 2 changes and both occurred during the period when the Fed was paying particular attention to M1. If the criterion was reduced to 1.5 standard errors, the number of simultaneous responses increases to six. Thus, it does not appear that the market's response to non-technical discount rate changes is pervasive. It is reasonable to expect discount rate changes to affect all three markets simultaneously. That this does not appear to be the case suggests that either the markets do not always respond to the announcement of a discount rate change or that, often, idiosyncratic shocks in a particular market mute the market's reaction. Either way, these results are troublesome for those who believe that discount rate changes have a consistent effect across short-term interest rates.

Troubling as the above results are, it is customary to gauge the market's average response to discount rate changes. This is done by imposing the constraints, $\beta_1=\beta_2=\ldots=\beta_N$, in Equation 3. With these restrictions, and allowing for a differential effect by the type of discount rate changes, Equation 3 can be written as

$$(4)\quad \Delta i_t = \alpha_o + \lambda\Delta DR(1)_t + \mu\Delta DR(2)_t + \delta\Delta DR(3)_t + \epsilon_t, \quad t=1, 2, \ldots, T.$$

Estimates of Equation 4 are reported in Table 4. On average, type 1 discount rate changes have no statistically significant effect on the federal funds rate, but have a significant effect on both the RP and

T-bill rates. This result, however, merely reflects the previously noted lack of a pervasive effect for type 1 discount rate changes, and the sensitivity of least-squares to "outliers." The statistical significance of RPR and TBR is due solely to one discount rate change, DR(1)20, when the Fed announced it would de-emphasize M1. When this discount rate change is deleted, the coefficients on the two rates drop to .183 and .042, respectively, and they are no longer statistically significant (the t-statistics are 1.86 and .808, respectively). Hence, consistent with our previous findings and all other empirical work, market interest rates generally do not respond significantly to type 1 discount rate changes.

Also, the average response of FFR to type 3 discount rate changes is larger than for type 2 changes, while the responses of both RPR and TBR are smaller. Consistent with the results of Cook and Hahn (1988), however, in no case is the difference statistically significant at the 5 percent level.

3.1 Are Discount Rate Changes Anticipated?

There are two possible explanations of why markets do not respond to type 1 discount rate changes. If type 1 changes are anticipated and the others are not, the effect of anticipated discount rate changes would already be reflected in market rates, so that the markets would react only to type 2 and 3 discount rates changes. Alternatively, type 2 and 3 discount rate changes are accompanied by a statement about policy or the state of the economy and type 1 changes are not. Consequently, type 2 and 3 changes provide the market with new information not provided by type 1 changes.

To test whether discount rate changes are anticipated, the equation

$$(5)\quad \Delta i_t = \alpha_o + \sum_{j=-K}^{-1} \mu_j \Delta DR(1)_{t-j} + \sum_{j=-K}^{-1} \delta_j \Delta DR(2+3)_{t-j} + \epsilon_t$$

is estimated, where K is the number of days prior to the announcement of a discount rate change. Because the response to type 2 and 3 discount rate changes is the same, they are combined. If type 1 discount rate changes lack an announcement effect because they are anticipated, the null hypothesis that the lead coefficients are jointly zero should be rejected. Conversely, if the type 2 and 3 discount rate changes are unanticipated, the corresponding null hypothesis should not be rejected.

The results of these tests for K = 10, 20 and 30 are presented in Table 5. For FFR the null hypothesis is rejected for both type 1 and type 2+3 discount rate changes for all three orders of the leads. Hence, they provide no support for the hypothesis that type 1 changes are anticipated, while the others are not. The results for RPR or TBR also provide little support for this hypothesis. These results are consistent with those of Hakkio and Pearce (1991), and suggest that technical discount rate changes are no more predictable than non-technical changes.[17] Type 1 discount rate changes do not provide new information about monetary policy or the economy. Consequently, they do not evoke an announcement effect.

3.2 Does the Announcement Effect Vary With the Fed's Operating Procedure?

The possibility that the announcement effect for non-technical discount rate changes varies with the Fed's operating procedure is

investigated by partitioning discount rate changes by whether they occurred before, during or after the period of non-borrowed reserve targeting, October 9, 1979 to October 6, 1982. Because there were only two type 3 discount rate changes during this period (one of them was made in October 9, 1979, coincident with the announcement of the move to monetary aggregate targeting), type 2 and type 3 changes are combined.[18] The results, reported in Table 6, are broadly similar for FFR and TBR. Unlike Smirlock and Yawitz and Roley and Troll, we find that the response of the TBR is statistically significant regardless of the Fed's operating procedure: the response was significantly larger during the non-borrowed reserves targeting period and not significantly different during the earlier and later periods.[19] The results for the federal funds rate are similar to those of the T-bill rate; however, the those for RPR differ slightly. The response during the period of non-borrowed reserves targeting was significantly larger than that for the other periods, however, there was no statistically significant response in the pre-nonborrowed reserve targeting period.[20]

Taken together, the results in Tables 3-6 show that although the response varies both in magnitude and intensity across rates and monetary policy operating regimes, market interest rates respond significantly only to discount rate changes that the Fed announces are made for other than purely technical reasons. The fact that the response to discount rate changes is significantly larger when the Fed was targeting non-borrowed reserves is not surprising because, as we have already noted, daily movements in interest rates were much larger during this period. The relevant issue is the size of the relative

response. Since these estimates were adjusted for heteroskedasticity, this question can be addressed by comparing the "t-statistics" during the three periods. This comparison suggests that with the possible exception of the TBR, the relative response was not larger when the Fed was targeting non-borrowed reserves. In any event, the fact that markets respond significantly during all three periods is consistent with the view that the response is to the new information that the announcement provided and not to a direct effect of discount rate changes on the supplies of money and credit.

3.3 Do Discount Rate Changes Signal a Change in Monetary Policy?

While the evidence suggests that there is an announcement effect, it is not clear whether markets responded because discount rate changes signal a change in monetary policy. One way to assess whether changes in the discount rate have historically signaled a change in policy is to see whether the growth rates of variables over which the Fed has direct control changed following discount rate changes.[21] The problem with implementing this test is that the growth rates of variables over which the Fed has direct control, non-borrowed reserves, total reserves and the adjusted monetary base, are only available weekly before February 1984 and biweekly thereafter. Moreover, these series are highly variable at that frequency so it is difficult to obtain precise measures of their average growth rates during short periods between discount rate changes. While the results of such tests are consistent with the conclusion that discount rate changes generally have not been indicative in monetary policy changes, they are not reliable.[22]

An alternative approach stems from the well-known observation supported by the results in Table 5, that interest rates generally drift in the direction of a discount rate change before the discount rate change is announced. This significant drift could stem from policy actions or from factors unrelated to policy. In either event, if a change in the discount rate signals a change in the growth rate of reserves or the monetary base, one might expect to see a change in the drift of interest rates. Finding no significant "shift in the drift" is consistent with the view that discount rate changes do not signal changes in monetary policy.

One can test a significant shift in the drift by estimating the equation

$$(6) \quad \Delta i_t = \alpha_o + \alpha_1 DRIFT_b + \alpha_2 DRIFT_a + \epsilon_t,$$

where $DRIFT_b$ is a dummy variable equal to one for K days before the discount rate change and zero otherwise and $DRIFT_a$ is a dummy variable equal to one for the day the discount rate change is effective and for the next K days and zero otherwise. Including the day of the significant announcement effect in $DRIFT_a$ biases the test in favor of finding a significant shift in the drift.[23] Because market rates generally do not respond to type 1 discount rate changes, only type 2 and 3 changes are used in these tests. Two drift parameters were estimated, one for positive changes in the discount rate (DRIFTPOS) and one for negative changes (DRIFTNEG).

Estimates of Equation 6 for the values of K, 5, 10 and 15, are presented in Table 7. The coefficients on the "before" drift variables are nearly always statistically significant and have the anticipated

sign, confirming the observation that the market tends to lead discount rate changes in the same direction. Differences between the "before" and "after" coefficients generally are not statistically significant, however. There were two instances where the difference is significant, for FFR for discount rate increases and for RPR for discount rate decreases. In these cases, however, as in nearly all others, the absolute magnitude of the differences gets smaller as K increases. Indeed, the difference is not statistically significant for RPR for K=15.

The evidence suggests that generally the Fed has not signaled policy changes with the discount rate. Of course, this does not mean that the Fed has never used discount rate changes for this purpose or that, on occasion, the market has not interpreted a discount rate change as a signal of a change in monetary policy even if that was not the Fed's intent.[24] Furthermore, the Fed may use the discount rate to communicate a change in its target for the federal funds rate. Such a change would not necessarily require a change in the growth rate of reserves, yet it could be interpreted by some as a change in monetary policy.[25] In any event, the fact that there is no evidence that the Fed changes its policy with respect to the growth rate of reserves or the monetary base following a change in the discount rate means that one should be careful about interpreting a change in the discount rate as a signal of a change in monetary policy. It seems equally plausible that the market responds to new information that the announcement provides about the health of the economy.

4. CONCLUSIONS AND IMPLICATIONS

A considerable volume of empirical literature has established that markets react to changes in the Federal Reserve's discount rate and a number of alternative hypotheses for this reaction have been suggested. This paper investigates the reaction of the federal funds, three-month T-bill and overnight RP rates to changes in the discount rate and presents the results of several tests designed to differentiate among competing hypotheses. The evidence suggests that the market's response is due simply to an announcement effect. Both intuition and empirical evidence reject the suggestion by Roley and Troll (1984) and Smirlock and Yawitz (1985) that market interest rates should not react to discount rate changes during periods when the Fed is targeting the federal funds rate.

The evidence presented here also challenges the hypothesis that markets do not respond to technical discount rate changes because they are anticipated. Both technical and non-technical changes tend to follow, rather than lead, the market, and the exact timing of either change cannot be anticipated perfectly. Consequently, it is hard to believe that the dramatic, and well-documented, difference in the market's response to the two types of discount rate changes is due solely to the market correctly anticipating technical discount rate changes, but not non-technical changes. It appears that markets do not respond to technical changes simply because such announcements provide no information.

The Fed has given a variety of explanations for making non-technical changes in the discount rate, and seldom makes a direct

statement of its policy intentions in announcing a discount rate change. Despite this fact, it is often assumed that the market responds to such changes because they "signal" a change in monetary policy. Making use of the fact that such discount rate changes follow, rather than lead the market, this proposition was tested indirectly. The results suggest that, historically, non-technical discount rate changes generally have not "signaled" a change in monetary policy.

These results are only suggestive, however. Certainly, they cannot rule out the possibility that a particular discount rate change conveyed information about monetary policy. Indeed, casual observation suggests that, at times, discount rate changes do convey such information. The most striking example of such an announcement is the one made in October 1979, when the Fed underscored its intent to fight inflation by announcing that it was raising the discount rate a full percentage point. This announcement was associated with 225, 90 and 112 basis-point changes in the federal funds rate, the over-night RP rate and the three-month T-bill rate, respectively, and with a dramatic change in the growth rates of reserves and the money supply. In this instance, however, the Fed simultaneously announced it was shifting to a "reserve-oriented" operating procedure. Hence, the market's response may have been due to the announcement of a shift in monetary policy and not to the announcement of a discount rate change *per se*. Nevertheless, this event suggests that the market does respond to new, significant policy information. Whether the response of the market to non-technical discount rate changes is always for this reason, much less clear.

Finally, a detailed analysis of the response to individual discount rate changes suggests that markets often do not appear to respond at all to non-technical discount rate changes, or that often the three interest rates used here do not appear to respond simultaneously. This suggests that the exact nature and anticipated usefulness of the information that such announcements provide may vary from announcement to announcement. While caution is required, it seems reasonable that identically worded announcements could have vastly different affects depending on the circumstances in the market at the time--including how much the market is taken by surprise. The results here merely suggest that the market's reaction to a non-technical discount rate change is an "announcement effect," that the announcement effect is invariant to the Fed's operating procedure, and that changing expectations about monetary policy is not the only reason--and perhaps not the most important reason--for the market's reaction.

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FOOTNOTES

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1. This literature includes Waud (1970), Lombra and Torto (1977), Brown (1981), Thornton (1982, 1986), Batten and Thornton (1984, 1985), Mudd (1979), Smirlock and Yawitz (1985) and Cook and Hahn (1988).

2. Roley and Troll (1984) term the market's response to a discount rate change an "announcement effect," however, their analysis rests on the assumption that discount rate changes are transmitted to market interest rates through their effect on the supply of borrowed reserves.

3. Announcements of discount rate changes rarely provide explicit reference to monetary policy. See the reasons for changing the discount rate given in Thornton (1982, 1986) and Batten and Thornton (1984).

4. Smirlock and Yawitz were concerned with the apparent discrepancy between the observation (Lombra and Torto (1977)) and Santomero (1983).

5. A variant of this explanation requires the Fed merely to remain committed to a given policy or operating procedure. In October 1979 the Fed switched to a non-borrowed reserves operating procedure. It is argued that under lagged reserves accounting, fixing the level of non-borrowed reserves is tantamount to fixing the level of aggregate borrowing. Because borrowing is a function of the spread between the funds rate and discount rate, many authors have interpreted this as fixing the level of the funds rate. Under these conditions, changes in the discount rate would be reflected in the funds rate point-for-point if the non-borrowed reserves target is unchanged and if the demand for borrowed reserves is stable. A similar analysis would hold for the post-October 1982 period. Since then, the Fed has followed a borrowed-reserves operating procedure. Under this procedure, too, there would be a one-to-one correspondence between changes in the discount rate and the federal funds rate.

Thornton (1988) discusses the effect of a discount rate change on the federal funds rate under a strict borrowed reserves operating procedure, where the demand for borrowed reserves is stable, and under a non-borrowed reserves operating procedure. The evidence is that the function is not stable, however, so this argument lacks credibility.

6. Waud (1970) provides a description of this hypothesis. He attributes it to Friedman (1959).

7. The details of this model are found in Thornton (1988).

8. It is interesting to note that this interpretation could not be correct since 1988 because, since then, borrowing has been unresponsive to even large changes in the spread between the federal funds and

discount rates. See Clouse (1990) for an analysis of discount window borrowing.

Roley and Troll (1984) conjecture about a possible announcement effect due to an anticipated change in monetary policy, stating that the "public may further infer a change in the entire short-run money stock path, causing the discount rate change to affect both short and long-term interest rates." However, this announcement effect is not an integral part of their analysis of the differential effect of discount rate changes under alternative Fed operating regimes.

9. See Thornton (1988) and Feinman (1990).

10. Such an action created a lot of hoopla in the press when the December 18, 1990 discount rate reduction, an action taken by the Board of Governors of the Federal Reserve System was allowed to "show through" to the federal funds rate, the short-run policy target of the FOMC. The Wall Street Journal (1991a,b).

11. The results for stock prices have been confirmed by the author but are not reported here.

12. Smirlock and Yawitz (1985) note this problem in a footnote, stating that if the timing uncertainty were the same for both types of discount rate changes, "market efficiency would lead us to assert that the announcement effect of a nontechnical change exceeds that associated with a technical change." Presumably, this is due to their interpretation of non-technical changes, which they assert "contain some informative policy implications." See Smirlock and Yawitz (1985), p. 1142. It should be noted, however, that most often such announcements do not give any direct information about the direction of monetary policy. "Informative policy implications" usually must be inferred. See Thornton (1982, 1986) and Batten and Thornton (1984) for paraphrased announcements for most of the discount rate changes used here.

13. Indeed, the direct effect should be somewhat larger for technical changes since the effect on the spread between the discount and market interest rates is larger in the case where the latter do not respond. Thornton (1986) presents two other pieces of evidence that suggest the money market's reaction is due to an announcement effect and not the direct effect. First, he notes that the response of market interest rates to changes in the discount rate should be larger under a borrowed reserves operating procedure if the response is due solely to a direct effect and shows that this is not the case. Indeed, the response is smaller, though not statistically so. Second, causality should run from FFR rate to TBR rate. He finds, however, unidirectional causality running from TBR to FFR.

14. To see this rewrite Equation 3 more compactly as $\Delta i = X\beta + \epsilon$, where Δi is a T by 1 vector of observations are the interest rates and X is T by N matrix of "observed" discount rate changes. Now $\hat{\beta} = (X' X)^{-1}X'\Delta i$ and the vector of t-statistics is just $\hat{\beta}/\hat{\sigma}$, where $\hat{\sigma}$ is the usual

least-squares estimate of the standard error. Some straight-forward algebra shows that the j^{th} element of this N by 1 vector is $\Delta i_j/\hat{\sigma}$. Because the equation is fit without error on each day when there is a change in the discount rate, $\hat{\sigma}$ is the estimated standard error on days when there are no changes in the discount rate.

15. The estimation was carried out via a two-step generalized least squares estimation procedure.

16. For FFR and RPR the hypothesis that the coefficients on the dummy variables for Wednesday and Thursday are equal with opposite signs cannot be rejected. However, the coefficients on RPR are much smaller than those on FFR. This suggests that the "Wednesday weakness" spills over nearly identically into Thursday.

Dummy variables for the first and last day of the year also were included in all equations; however, they were never statistically significant so they are not reported.

17. Hakkio and Pearce do not address this question directly; however, this result can be obtained by simply comparing their results for technical and non-technical discount rate changes.

18. The equation was also estimated by including the type 2 and 3 changes separately, the results are quantitatively and qualitatively similar to those presented here.

19. The difference between these results and those reported by Roley and Troll (1984) can likely be explained by their failure to distinguish between technical and non-technical discount rate changes, their short sample for the pre-nonborrowed reserves operating procedure and their failure to adjust for heteroskedasticity. The discrepancy between our results and those of Smirlock and Yawitz is more difficult to explain because they differentiated between technical and non-technical changes. Although their sample period, January 2, 1975 to October 5, 1979, is somewhat shorter, it contains nine of the fourteen type 2 and type 3 discount rate changes considered here for the pre-nonborrowed reserve targeting period. Hence, the difference is likely due to something else, perhaps a misalignment of changes on the funds rate with changes in the discount rate. In any event, the results here clearly show that there was a statistically significant response of the T-bill rate to non-technical discount rate changes for periods of federal funds rate targeting both <u>before</u> and <u>after</u> the Fed's flirtation with a non-borrowed reserves operating procedure.

20. Very early in the sample, RPR appeared to lack variability. These data are of suspicious quality until about the mid-1970s.

21. Cook and Hahn (1988) offer a particular variant of this hypothesis, arguing that non-technical discount rate changes signal the Fed's intention to change its target level for the federal funds rate. Their analysis suggests that the T-bill rate should change point-for-point with the federal funds rate; however, the evidence presented here suggests that this is not the case. Indeed, the null hypothesis that the response of the federal funds and T-bill rates is equal for $\Delta DR(2+3)$ is easily rejected. The "t-statistic" for an asymptotic test of this hypothesis is 5.77, compared with a critical value of 2.33 at the 1 percent significance level. For a critical analysis of Cook and Hahn's results, see Thornton (1991).

22. In an attempt to provide some direct evidence on this question, the growth rates of two reserve aggregates, total reserves (adjusted for reserve requirement changes) and non-borrowed reserves, were regressed on dummy variables for K-periods before and after type 2 and 3 discount rate changes. These estimates were adjusted for heteroskedasticity using White's (1980) consistent estimator. Because the anticipated direction of the change in the growth rate depends on the direction of the discount rate change, the dummy variables associated with discount rate increases were multiplied by negative one. Hence, under the usual hypothesis, there should be a significant negative relationship between changes in the discount rate and changes in the growth rates of these reserve aggregates [This is essentially the "event study" analysis of Brown and Warner (1980, 1985)]. The equations were estimated using biweekly data for the entire sample period and weekly data prior to the Fed's switch to a two-week reserve maintenance period in February 1984. Several values of K were used. In nearly all cases the coefficients on the dummy variables were not significant and, they were not even negative when weekly data were used. There was only one instance where the results were consistent with the conventional view, using total reserves and biweekly data with K=10. The adjusted R-square for this equation was very low (less than .015), however, and the results were very sensitive to the choice of K. Hence, these results provide no support for the notion that discount rate changes signal a change in monetary policy.

23. Because of this, the tests were also done by simply using K days before and after the announcement. Done in this way, the relevant F-test was statistically significant only for positive changes for the federal funds rate. And then only for K equal to 5 or 10.

24. October 6, 1979 is an example of an instance when the Fed underscored its policy intentions with a discount rate change.

25. Indeed, the fact that market rates respond immediately to changes in the discount rate, but that there is no significant "shift in the drift" suggests discount rate changes result in a permanent change in interest rates. As noted earlier, however, this results stems directly from the random walk specification, where all shocks are permanent--such specifications do not allow for the dynamic response of the structure of interest rates to such shocks.

Table 1

Changes in the Discount Rate by Type

Number	Effective Date	ΔDR	ΔFFR	ΔRPR	ΔTBR
			Type 1		
1	01/15/73	0.50	0.125	0.00	0.03
2	04/23/73	0.25	-0.500	0.00	0.06
3	05/11/73	0.25	0.187	0.12	0.23
4	08/14/73	0.50	-0.150	0.13	0.23
5	02/05/75	-0.50	-1.740	-0.94	-0.15
6	05/16/75	-0.25	0.010	-0.07	0.01
7	01/19/76	-0.50	-0.030	0.00	-0.08
8	11/22/76	-0.25	-0.060	-0.15	-0.06
9	08/30/77	0.50	-0.010	0.00	0.02
10	10/26/77	0.25	0.110	-0.05	-0.05
11	05/11/78	0.50	0.040	0.05	-0.07
12	07/03/78	0.25	-0.370	0.00	-0.06
13	09/19/79	0.50	-0.420	0.00	-0.20
14	05/29/80	-1.00	-1.740	0.25	0.22
15	06/13/80	-1.00	-0.040	-0.20	-0.02
16	07/28/80	-1.00	0.340	0.10	0.16
17	11/02/81	-1.00	0.620	0.00	-0.06
18	12/04/81	-1.00	-0.820	-0.20	-0.58
19	08/27/82	-0.50	0.550	1.00	0.70
20	10/12/82	-0.50	-0.430	-0.70	-0.37
21	04/09/84	0.50	-0.050	-0.15	-0.09
22	04/21/86	-0.50	0.290	0.15	0.00
23	07/11/86	-0.50	-0.310	-0.30	-0.10
			Type 2		
1	02/26/73	0.50	0.375	0.19	0.21
2	06/11/73	0.50	0.188	-0.19	0.08
3	04/25/74	0.50	0.950	0.63	0.19
4	12/09/74	-0.25	0.030	0.19	-0.18
5	03/10/75	-0.50	-0.100	0.04	0.06
6	09/22/78	0.25	0.010	-0.05	0.11
7	10/16/78	0.50	0.110	0.05	0.06
8	07/20/79	0.50	0.200	-0.05	0.16
9	09/26/80	1.00	0.690	0.80	0.46
10	11/17/80	1.00	1.990	1.15	0.80
11	12/05/80	1.00	1.210	2.45	0.98
12	05/05/81	1.00	-0.280	-0.20	0.60
13	07/20/82	-0.50	-0.870	-0.45	-0.40
14	08/02/82	-0.50	-0.580	-1.40	-0.81
15	08/16/82	-0.50	-0.470	-0.40	-0.58
16	11/22/82	-0.50	-0.270	-0.40	-0.14
17	12/24/84	-0.50	-0.530	-0.55	-0.13
18	05/20/85	-0.50	-0.250	-0.50	-0.14
19	03/07/86	-0.50	-0.270	-0.10	-0.08
20	08/09/88	0.50	0.050	0.00	0.22

Table 1 Continued
(Page 2)

		Type 3			
Number	Effective Date	ΔDR	ΔFFR	ΔRPR	ΔTBR
1	07/02/73	0.50	1.125	0.19	0.38
2	01/06/75	-0.50	-0.520	-0.44	-0.06
3	01/09/78	0.50	0.170	0.05	0.39
4	08/21/78	0.50	0.200	0.05	-0.04
5	11/01/78	1.00	0.520	0.10	0.10
6	08/17/79	0.50	-0.300	-0.05	0.06
7	10/09/79	1.00	2.250	0.90	1.12
8	02/15/80	1.00	0.370	0.20	0.57
9	12/14/82	-0.50	-0.440	-0.30	-0.32
10	11/23/84	-0.50	-0.350	-0.30	-0.10
11	08/21/86	-0.50	-0.300	-0.40	-0.13
12	09/04/87	0.50	0.010	0.00	0.19
13	02/24/89	0.50	0.190	0.20	0.04

Table 2

Variances of Daily Changes in FFR, RPR and TBR

	WTH	MTF	F
		1/3/72 -- 10/5/79	
FFR	.3989	.0312	12.78*
RPR	.0690	.0309	2.23*
TBR	.0096	.0132	0.72
		10/8/79 -- 10/5/82	
FFR	1.0790	.3946	2.73*
RPR	.3913	.3366	1.16
TBR	.0528	.1058	0.50
		10/6/82 -- 2/1/84	
FFR	.1162	.0746	1.56*
RPR	.0919	.2010	0.46
TBR	.0044	.0095	0.46
		2/2/84 -- 8/9/89	
FFR	.5687	.1042	5.46*
RPR	.6200	.0593	10.45*
TBR	.0056	.0067	0.83

* indicates statistical significance at the 5 percent level.

Table 3

Estimates of Equation 3

Independent Variable	FFR	RPR	TBR
Constant	-1.53	0.97	2.95*
DR(1) 1	0.75	-0.08	0.20
DR(1) 2	-2.34*	-0.24	0.53
DR(1) 3	1.28	0.79	2.06*
DR(1) 4	-0.01	0.86	2.02*
DR(1) 5	9.90*	5.67*	1.30
DR(1) 6	0.07	0.34	0.05
DR(1) 7	0.14	0.14	0.90
DR(1) 8	0.38	0.95	0.43
DR(1) 9	0.06	0.05	0.02
DR(1) 10	0.88	-0.02	-0.38
DR(1) 11	-0.37	-0.10	-0.64
DR(1) 12	-1.74**	-0.04	-0.71
DR(1) 13	-1.71**	0.38	-1.90**
DR(1) 14	2.35*	-0.28	-0.69
DR(1) 15	0.52	0.64	0.11
DR(1) 16	-0.59	-0.20	-0.46
DR(1) 17	-0.76	0.14	0.21
DR(1) 18	1.17	0.22	2.06*
DR(1) 19	-0.85	-1.51**	-2.48*
DR(1) 20	2.76*	3.28*	4.97*
DR(1) 21	0.15	-0.45	-1.01
DR(1) 22	-1.09	-0.40	0.16
DR(1) 23	1.52**	1.62**	1.21
DR(2) 1	2.09*	0.80	1.89**
DR(2) 2	1.20	-0.75	0.76
DR(2) 3	4.32*	2.88*	1.84**
DR(2) 4	0.29	-0.89	1.72**
DR(2) 5	0.74	-0.16	-0.35
DR(2) 6	0.20	-0.31	1.04
DR(2) 7	0.49	0.30	0.41
DR(2) 8	1.26	-0.61	1.41
DR(2) 9	1.30	1.37	1.39
DR(2) 10	3.24*	2.09*	2.72*
DR(2) 11	2.32*	4.83*	3.39*
DR(2) 12	0.05	0.16	1.56**
DR(2) 13	1.75**	1.44	1.62**
DR(2) 14	0.84	2.66*	2.83*

Table 3 Continued
Page 2

Independent Variable	FFR	RPR	TBR
DR(2) 15	0.85	0.54	1.98**
DR(2) 16	1.77**	2.33*	1.48
DR(2) 17	2.57*	3.12*	1.69**
DR(2) 18	1.10	2.55*	1.88**
DR(2) 19	1.37	0.68	0.81
DR(2) 20	0.09	0.07	2.77*
DR(3) 1	6.50*	1.50**	3.35*
DR(3) 2	2.91*	2.88*	0.47
DR(3) 3	0.78	0.30	3.55*
DR(3) 4	1.32	0.47	-0.50
DR(3) 5	3.38*	0.92	0.97
DR(3) 6	0.22	0.06	0.56
DR(3) 7	3.62*	1.55**	3.94*
DR(3) 8	0.76	0.30	1.97**
DR(3) 9	2.10*	1.49**	4.03*
DR(3) 10	2.26*	2.58*	0.96
DR(3) 11	1.43	2.27*	1.58**
DR(3) 12	0.04	0.13	2.11*
DR(3) 13	1.09	1.54**	0.31

* indicates t-statistics greater than two.
** indicates t-statistics greater than 1.5.

Absolute value of t-statistics in parentheses.

Table 4

Response of Interest Rates to Discount Rate Changes by Type

Independent Variable	Interest Rate FFR		RPR		TBR	
Constant	-.032	-.031	.013	.013	.056*	.055*
	(1.72)	(1.70)	(0.69)	(0.70)	(3.02)	(3.01)
ΔDR(1)	.161	.161	.245*	.245*	.109*	.109*
	(1.41)	(1.41)	(2.57)	(2.56)	(2.20)	(2.21)
ΔDR(2)	.582*		.423*		.332*	
	(5.24)		(4.33)		(6.60)	
ΔDR(3)	.775*		.370*		.287*	
	(6.48)		(3.79)		(5.83)	
ΔDR(2+3)		.671*		.395*		.309*
		(8.24)		(5.72)		(8.78)
$\bar{R}^2$	.094	.094	.123	.123	.044	.044
F_1	6.99*		1.71		9.98*	
F_2	1.40		0.15		0.41	
F_3	13.79*		0.84		6.50*	
F_4	7.33*		0.91		5.62*	

* indicates statistical significance at 5 percent level.

Absolute value of t-statistics in parentheses.

F_1 tests the null hypothesis that $\lambda = \mu$
F_2 tests the null hypothesis that $\mu = \delta$
F_3 tests the null hypothesis that $\lambda = \delta$
F_4 tests the null hypothesis that $\lambda = \mu = \delta$

Table 5

Tests of the Anticipated Discount Rate Change

Interest Rate	Type of Discount Rate Change	Length of the Lead 10	20	30
FFR	1	1.95*	2.06*	2.53*
	2+3	3.36*	2.08*	2.09*
RPR	1	1.52	1.40	1.95*
	2+3	1.73	1.33	1.79*
TBR	1	1.65	1.69*	1.34
	2+3	3.41*	2.64*	2.26*

* indicates statistical significance at the 5 percent level.

Table 6

Response of Interest Rates to Discount Rate Changes, Partitioned Around the Period of Non-Borrowed Reserve Targeting

Independent Variable	Interest Rate FFR	RPR	TBR
Constant	-.032	-.004	.054*
	(1.73)	(.21)	(2.92)
ΔDR(1) Pre	.060	.245*	.072
	(.40)	(1.98)	(.99)
ΔDR(1) During	.130	-.007	-.001
	(.45)	(.03)	(.01)
ΔDR(1) Post	.386	.363	.207*
	(1.77)	(1.80)	(2.55)
ΔDR(2+3) Pre	.621*	.164	.229*
	(5.72)	(1.82)	(4.23)
ΔDR(2+3) During	1.202*	1.029*	.744*
	(5.00)	(4.63)	(6.96)
ΔDR(2+3) Post	.572*	.589*	.281*
	(4.00)	(4.48)	(5.52)
$\bar{R}^2$	.094	.077	.048
F_1	4.86*	12.98*	18.54*
F_2	.07	7.10*	.51
F_3	5.07*	2.89*	15.24*

* indicates statistical significance at the 5 percent level.

Absolute value of t-statistics in parentheses.

F-tests are only for type 2 and 3 discount rate changes.

F_1 tests the hypothesis that Pre = During.
F_2 tests the hypothesis that Pre = Post.
F_3 tests the hypothesis that During = Post.

Table 7

Tests For Permanent Effects: The Drift Results

Independent Variable	Interest Rate								
	FFR			RPR			TBR		
	K=5	K=10	K=15	K=5	K=10	K=15	K=5	K=10	K=15
Constant	-.032	-.044*	-.050*	.021	.013	.006	.055*	.054*	.051*
	(1.70)	(2.26)	(2.52)	(1.15)	(0.69)	(0.30)	(2.92)	(2.78)	(2.60)
DRIFTPOS(b)	.039	.047*	.036*	.018	.053*	.033*	.028*	.016*	.016*
	(1.45)	(2.43)	(2.20)	(0.84)	(3.47)	(2.58)	(2.43)	(2.00)	(2.37)
DRIFTPOS(a)	.160*	.132*	.101*	.052*	.037*	.047*	.027*	.023*	.021*
	(6.51)	(7.06)	(6.18)	(2.64)	(2.50)	(3.63)	(2.52)	(2.81)	(3.06)
DRIFTNEG(b)	-.104*	-.065*	-.041*	-.047	-.027	-.022	-.035*	-.018*	-.019*
	(3.16)	(2.71)	(2.02)	(1.66)	(1.32)	(1.32)	(2.85)	(2.01)	(2.54)
DRIFTNEG(a)	-.133*	-.075*	-.041*	-.137*	-.081*	-.046*	-.020	-.019*	-.015*
	(4.34)	(3.28)	(2.04)	(5.20)	(4.15)	(2.74)	(1.74)	(2.23)	(2.02)
F(POS)	11.52*	9.02*	6.44*	1.44	.52	.45	.00	.29	.22
F(NEG)	.43	.09	.00	5.43*	3.44*	.81	.83	.01	.13
$\bar{R}^2$	.094	.096	.092	.123	.124	.124	.031	.031	.033

* indicates statistical significance at the 5 percent level.

Absolute value of t-statistics in parentheses.

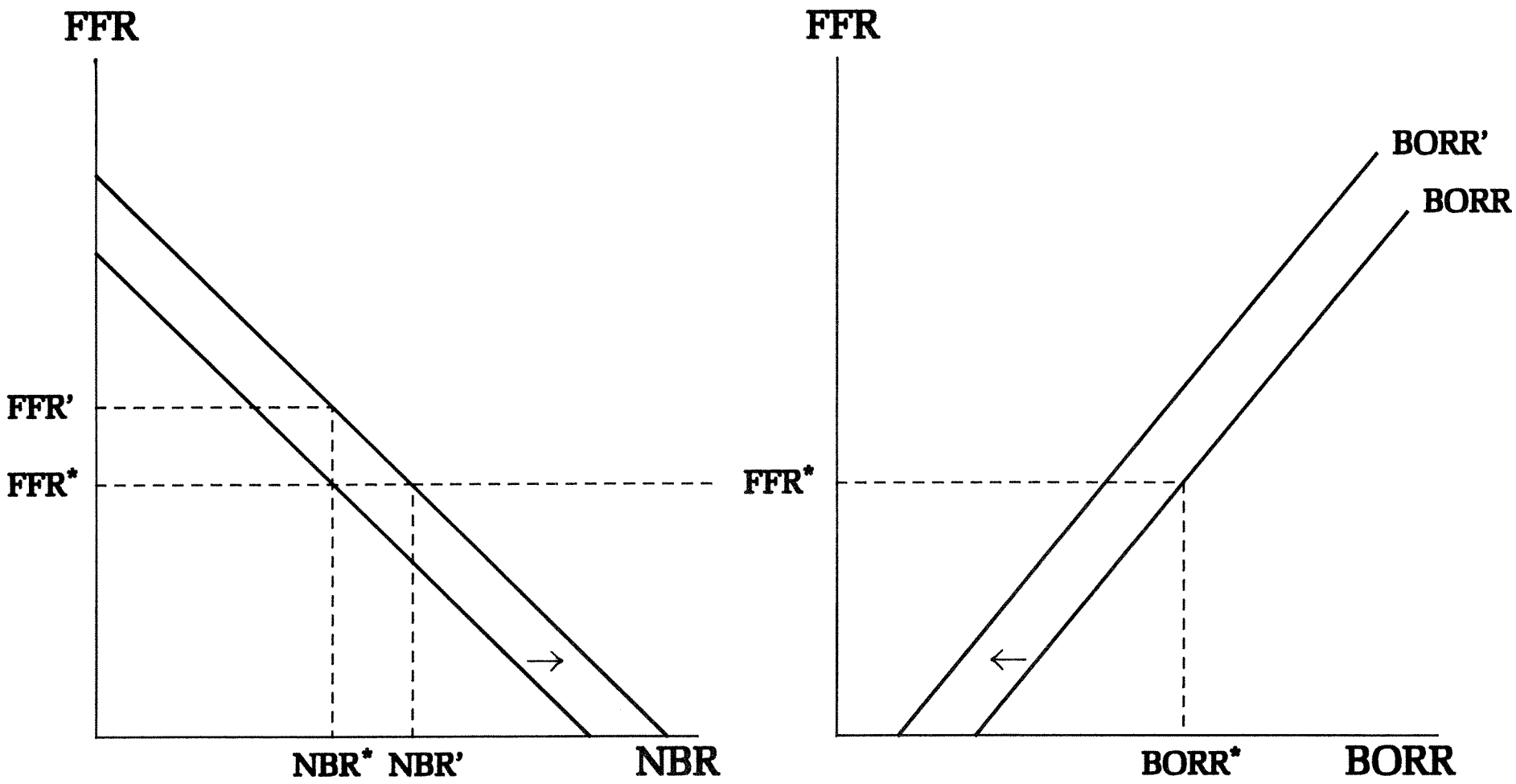
FFR
FFR'
FFR*
NBR*
NBR'
NBR
Panel A
FFR
BORR'
BORR
FFR*
BORR*
BORR
Panel B

Figure 1